# PHYTOTOXICOLOGY SURVEY REPORT: VEGETATION SURVEY IN THE VICINITY OF WELLAND CHEMICAL SARNIA (1995)

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Report prepared by:

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## BACKGROUND

Welland Chemical, located on Scott Road in Sarnia, is a manufacturer of anhydrous aluminum chloride. The product is manufactured by passing gaseous chlorine through molten aluminum and precipitating out the desired product. During the removal of the product from the precipitators and in the subsequent handling and packaging, fugitive emissions of the product occur. The product reacts with the moisture in the air to produce hydrochloric acid and aluminum oxide. Complaints of vegetation damage in the immediate vicinity of the company have been documented since 1970.

The Phytotoxicology Section of the Ministry of Environment and Energy has carried out vegetation assessment surveys in the vicinity of Welland Chemical Ltd. since 1970. These surveys were conducted continuously from 1978 to 1987 and then in 1989 and 1991 (see reference list for report titles and frequency). During the course of each investigation, injury to vegetation has been observed and documented at sites in the vicinity of the company. This injury has been attributed to emissions from Welland Chemical. Injury symptoms, which usually develop in late July, are typical of those induced by chloride. Chemical analysis of survey foliage has revealed sharply elevated levels of aluminum and chloride in vegetation located at sites near Welland Chemical.

The most recent study, conducted in 1991, found chloride-type vegetation injury at 3 survey sites close to Welland Chemical. The most severe injury occurred at Site 7 located 100 m north of the factory. Chemical analysis showed that both chloride and aluminum concentrations in bur oak foliage were highest at this site. The 1991 chloride level of 1.00% was the highest encountered at this location since the inception of vegetation sampling in 1970. As well, concentrations of iron, cobalt, copper, lead, manganese, nickel, strontium and vanadium were also noticeably elevated at this site. Overall, the sodium and aluminum content in foliage at sites closest to Welland Chemical was higher in 1991 than 1989. With respect to sodium, the mean concentration at sites close to the plant were the highest since 1982. Based on the visual and analytical data, it was concluded that fugitive emissions from Welland Chemical continued to adversely affect vegetation in a relatively small area, mainly to the west, north and east of the factory.

This report summarizes the results of sampling conducted in August 1995 by the Phytotoxicology Section, Standards Development Branch, at the request of the Ministry's Sarnia District office. At the time of the investigation the plant had been closed as the result of labour disputes for approximately one and a half years. This shut-down provided a good opportunity to test earlier conclusions that activities at the plant had contaminated the local environment.

## METHODOLOGY

Triplicate samples of bur oak foliage (*Quercus macrocarpa*), were collected at 11 survey sites - all situated within 750 metres of Welland Chemical (see attached Figure). Foliage samples for chemical analysis were collected in accordance with standard Phytotoxicology sampling techniques (10). The 1995 survey sites are the same as those that have been visited since 1978. At each site, indigenous plant species, particulary those sensitive to chloride, were examined for air pollution injury.

All samples were delivered to the Phytotoxicology processing laboratory in Toronto where they were dried and ground. Processed samples were then submitted to the Ministry's Inorganic Trace Contaminants Section, Laboratory Services Branch for chemical analysis. The samples were analyzed for aluminum (Al), beryllium (Be), barium (Ba), boron (B), calcium (Ca), cadmium (Cd), chloride (Cl), cobalt (Co), copper (Cu), iron (Fe), magnesium (Mg), manganese (Mn), molybdenum (Mo), nickel (Ni), potassium (K), lead (Pb), strontium (Sr), sulphur (S), vanadium (V) and zinc (Zn).

At each survey site, indigenous plant species (particularly those with known sensitivity to chloride), were examined for evidence of chloride-type injury symptoms.

## RESULTS and DISCUSSION

Mean concentrations of inorganic elements for replicate samples collected from each site are summarized in the attached table.

As indicated previously, elevated foliar Cl concentrations and associated vegetation damage have been found in earlier studies to be associated with emissions from Welland Chemical. Unlike earlier studies, there were no sites in the vicinity of Welland Chemical in the 1995 study that had elevated foliar Cl concentrations. Concurrently, none of the sites sampled exceeded the Phytotoxicology Upper Limit of Normal (ULN) guideline for Cl in foliage. The derivation and significance of the ULN guidelines are described in the attached Appendix. In comparison, 6 of the same 11 sites exceeded the ULN in 1991 when the plant was in operation. Chloride concentrations in bur oak foliage are illustrated in the attached figure for the 3 sites closest to Welland Chemical (Sites 1, 4 and 7) from 1982 to 1995. The figure clearly illustrates the dramatic drop in Cl concentrations in foliage in the vicinity of the plant in 1995.

Historically, Al concentrations in foliage in the vicinity of Welland Chemical tended to be higher than at sites more removed from the facility. Although the survey in 1991 found that most sites were below the ULN, concentrations of Al in foliage increased at 9 of the 12 survey sites from 1989 to 1991. In contrast, the concentrations of Al in foliage in the 1995 survey were very low and well below the ULN. For example, the most significant Al increases from 1989 to 1991, which occurred at Sites 4 and 7, resulted in foliar Al concentrations of 225 and 395 µg/g, respectively. The concentrations of Al in foliage at these same sites in 1995 were 40 and 35 µg/g, respectively.

The high Fe concentrations found in the past for this survey were thought to be associated with materials handling on the adjacent rail line. While the highest Fe concentration in foliage in 1995 occurred close to Welland Chemical at Site 7 (330 µg/g), it was well below the ULN and had dropped from 890 µg/g in 1991.

Similarly, the analytical results for other elements indicate that the concentrations in plant tissue around the facility were, with one exception (Mo at Site 10), well within the range considered normal for an urban area. In addition, there was no consistent trend toward increased concentration of elements in tree foliage near and/or downwind of the facility.

Unlike previous years there was no evidence of Cl-type injury symptoms on vegetation in 1995, including those with known sensitivity to Cl. These observations are consistent with the 1995 analytical results.

## SUMMARY

Welland Chemical in Sarnia is a facility that manufactures anhydrous aluminum chloride. In the past, fugitive emissions of the product have escaped to the surrounding environment during the recovery and packaging processes. The Phytotoxicology Section has monitored the effects of the emissions on vegetation in the vicinity of the chemical plant periodically since 1970. This survey was conducted in August 1995 to investigate the concentrations of elements in vegetation around the facility during an extended shut-down of operations at the plant.

The analytical results for inorganic elements indicated that the concentrations in plant tissue around Welland Chemical were well within the range considered normal for an urban area and there were no consistent trends toward increased concentration of elements in tree foliage near and/or downwind of the facility. The data clearly document the dramatic drop in Cl, and to a lesser extent Al, concentrations in foliage in the vicinity of the plant in 1995. Unlike previous years, there was no evidence of Cl-type injury symptoms on vegetation in the vicinity of the facility. Together the chemical and observational data re-affirm the finding that historical contamination was caused by emissions from Welland Chemical and that the cessation of activities has resulted in dramatically reduced foliar contamination and no vegetation injury.

## REFERENCES


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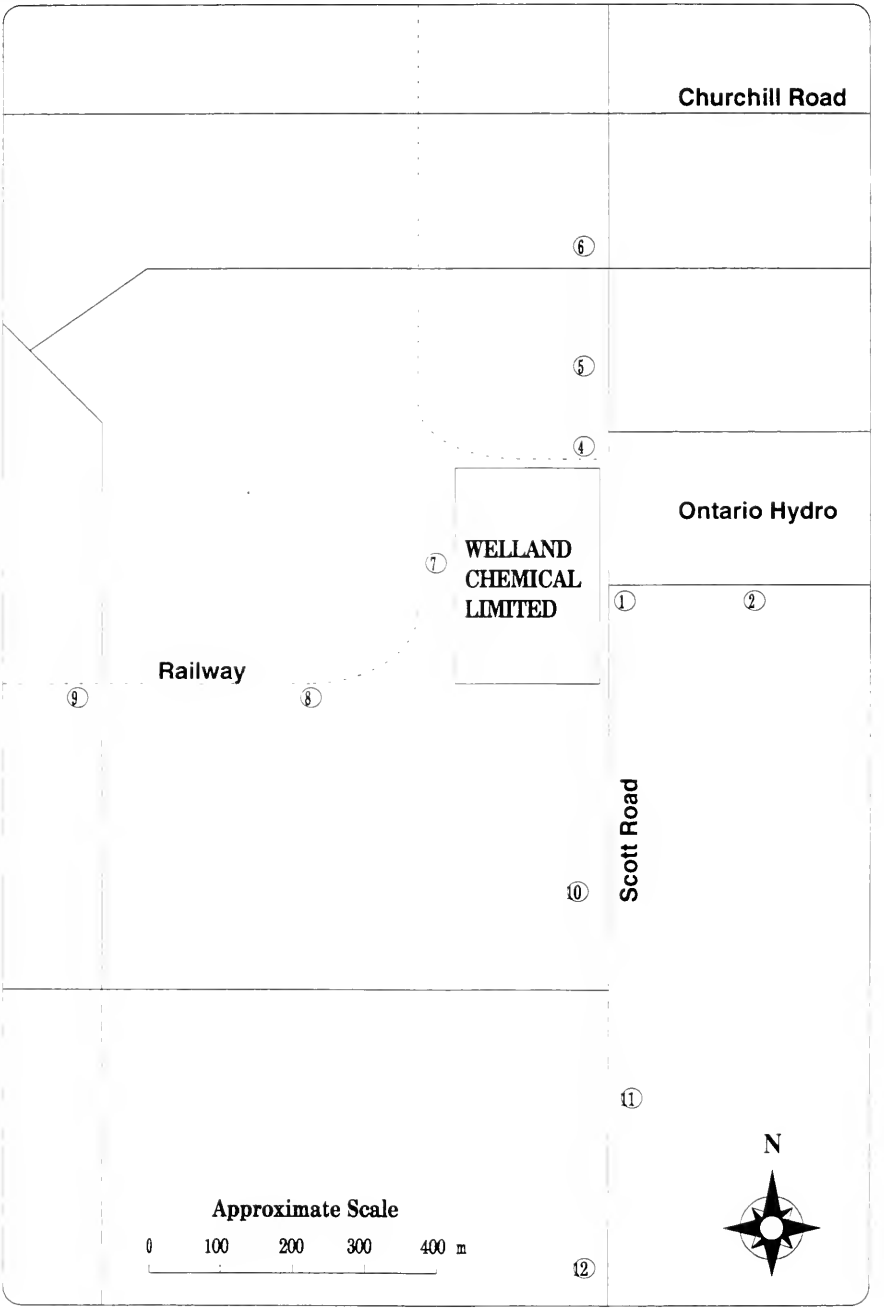
Concentrations* of Elements in Burr Oak Foliage Collected in the Vicinity of Welland Chemical, Sarnia - August 1995.

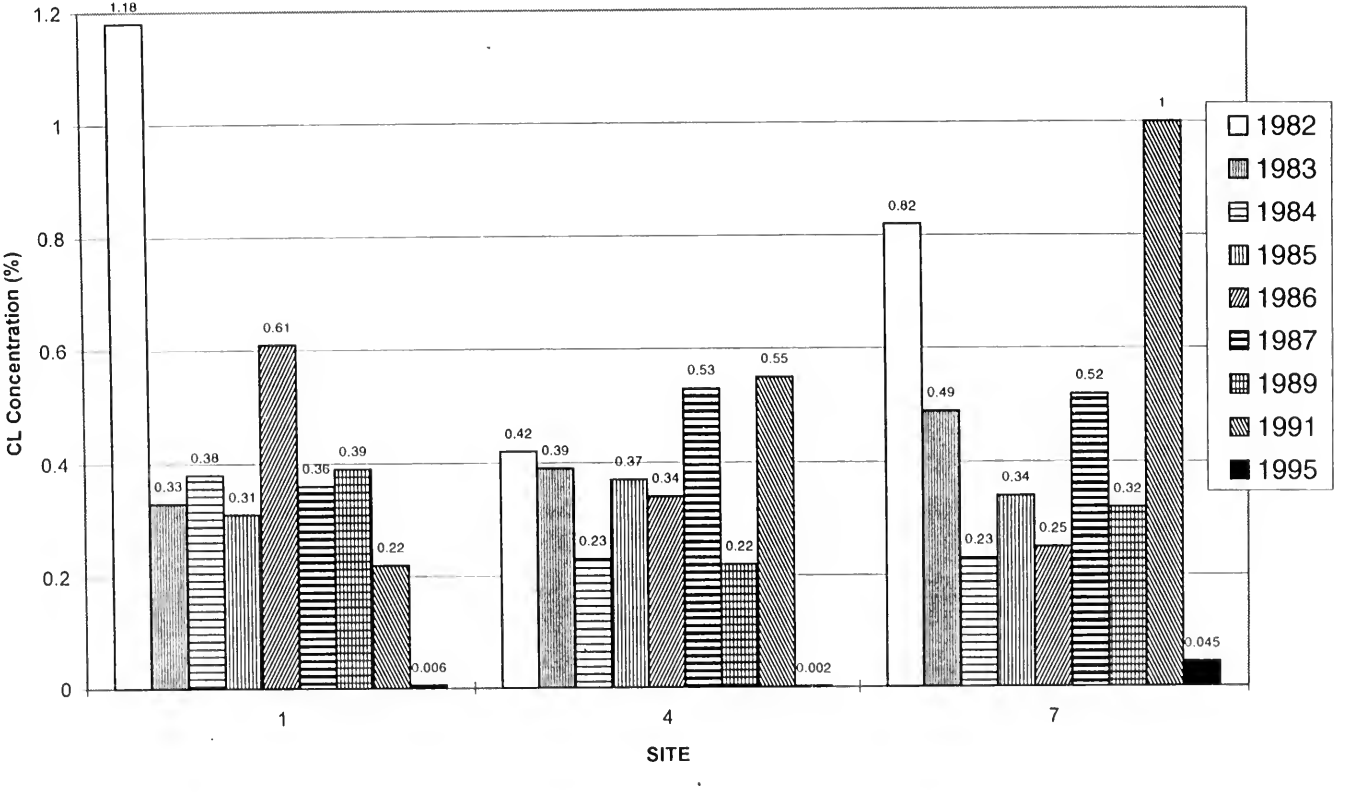
| Site | Al | Be | Ba | B | Ca | Cd | Co | Cu | Cr | Fe | Mg | Mn | Mo | Ni | Pb | Sr | V | Zn | Cl | S | K |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 - 150 m E | 43 | 0.2 W | 13 | 38 | 12000 | 0.1 W | 0.2 W | 7.0 | 0.8 T | 100 | 2100 | 10 | 0.6 T | 1.0 T | 0.5 W | 20 | 0.6 T | 22 | 0.006 | 0.15 | 0.99 |
| 2 - 350 m E | 34 | 0.2 W | 9 | 52 | 8300 | 0.1 W | 0.2 W | 6.6 | 0.5 W | 110 | 2000 | 67 | 0.2 T | 0.8 T | 0.5 W | 10 | 0.7 T | 23 | 0.032 | 0.17 | 1.1 |
| 4 - 175 m N | 40 | 0.2 W | 10 | 51 | 7500 | 0.1 W | 0.2 W | 5.5 | 0.5 W | 83 | 2400 | 48 | 1.3 | 0.9 T | 0.5 W | 11 | 0.5 W | 17 | 0.002 W | 0.20 | 0.97 |
| 5 - 275 m N | 45 | 0.2 W | 11 | 102 | 8700 | 0.1 W | 0.2 W | 6.5 | 0.5 W | 103 | 1400 | 37 | 0.7 T | 1.0 T | 0.7 T | 13 | 0.8 T | 30 | 0.029 | 0.19 | 1.1 |
| 6 - 425 m N | 46 | 0.2 W | 7 | 63 | 6800 | 0.1 W | 0.2 W | 6.7 | 0.5 W | 120 | 2100 | 37 | 0.5 T | 0.9 T | 0.6 T | 10 | 0.9 T | 25 | 0.028 | 0.17 | 1.1 |
| 7 - 100 m W | 35 | 0.2 W | 12 | 100 | 7500 | 0.1 W | 0.2 W | 6.7 | 0.5 W | 330 | 2000 | 96 | 0.5 T | 0.7 T | 0.8 T | 7 | 0.8 T | 21 | 0.045 | 0.17 | 1.2 |
| 8 - 350 m WSW | 34 | 0.2 W | 19 | 100 | 8900 | 0.1 W | 0.2 W | 5.1 | 0.5 W | 127 | 1500 | 56 | 0.6 T | 0.9 T | 0.6 T | 21 | 0.8 T | 15 | 0.002 W | 0.17 | 0.99 |
| 9 - 600 m WSW | 29 | 0.2 W | 10 | 59 | 9300 | 0.1 W | 0.2 W | 5.3 | 0.5 W | 76 | 1500 | 84 | 0.4 T | 0.7 T | 0.6 T | 11 | 0.5 W | 15 | 0.085 | 0.16 | 0.95 |
| 10 - 400 m S | 53 | 0.2 W | 11 | 89 | 12000 | 0.1 W | 0.2 W | 5.9 | 0.5 W | 140 | 2600 | 37 | **1.8** | 0.7 T | 0.7 T | 20 | 0.5 W | 19 | 0.002 W | 0.19 | 0.96 |
| 11 - 700 m S | 108 | 0.2 W | 8 | 64 | 12000 | 0.1 W | 0.2 W | 6.0 | 0.5 W | 170 | 2100 | 72 | 0.6 T | 1.1 T | 1.1 T | 14 | 0.8 T | 26 | 0.09 | 0.13 | 0.96 |
| 12 - 900 m S | 58 | 0.2 W | 7 | 49 | 5900 | 0.1 W | 0.2 W | 4.3 | 0.5 W | 160 | 1700 | 86 | 0.2 W | 0.5 W | 1.0 T | 7 | 0.7 T | 21 | 0.06 | 0.20 | 0.85 |
| ULN (Urban) | 500 | NG | NG | 175 | 30000 | 2 | 2 | 20 | 8 | 1000 | 7000 | 100 | 1.5 | 7 | 60 | NG | 5 | 250 | 0.15 | 0.4 | NG |

* ug/g dry weight, mean of triplicate samples and analysis (except for Cl, S and K expressed in %)
NG No guideline currently available.
T A measurable trace amount. Interpret with caution.
W Less than analytical detection limit.
ULN Upper Limit of Normal Phytotoxicology guideline for urban tree foliage (see appendix).
Values underlined and in bold exceed ULN guideline.

Sketch Map of Vegetation Sampling Locations in the Vicinity of Welland Chemical, Sarnia 1995.



## Chloride Concentrations in Unwashed Bur Oak Foliage Collected in the Vicinity of Welland Chemical (1982-1995)



# APPENDIX

Derivation and Significance of the MOEE Phytotoxicology
"Upper Limits of Normal" Contaminant Guidelines.

The MOEE Upper Limits of Normal (ULN) contaminant guidelines represent the expected maximum concentration in surface soil, foliage (trees and shrubs), grass, moss bags, and snow from areas in Ontario not exposed to the influence of a point source of pollution. Urban ULN guidelines are based on samples collected from developed urban centres, whereas rural ULN guidelines were developed from non-urbanized areas. Samples were collected by Phytotoxicology staff using standard sampling procedures (ref: Ontario Ministry of the Environment 1983, Phytotoxicology Field Investigation Manual). Chemical analyses were conducted by the MOEE Laboratory Services Branch.

The ULN is the arithmetic mean, plus three standard deviations of the mean, of the suitable background data. This represents 99% of the sample population. This means that for every 100 samples which have not been exposed to a point source of pollution, 99 will fall within the ULN.

The ULN do not represent maximum desirable or allowable limits. Rather, they are an indication that concentrations that exceed the ULN may be the result of contamination from a pollution source. Concentrations that exceed the ULN are not necessarily toxic to plants, animals, or people. Concentrations that are below the ULN are not known to be toxic.

ULN are not available for all elements. This is because some elements have a very large range in the natural environment and the ULN, calculated as the mean plus three standard deviations, would be unrealistically high. Also, for some elements, insufficient background data is available to confidently calculate ULN. The MOEE Phytotoxicology ULN are constantly being reviewed as the background environmental data base is expanded. This will result in more ULN being established and may amend existing ULN.